"DOUBLE EMISSION OF HEAVY FRAGMENTS ($Z \geqslant 3$) IN THE DISINTEGRATION OF EMULSION NUCLEI"

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Plate I

ABSTRACT. Among 405 'hammer' tracks which are observed in the interactions of 4.6 GeV/C negative pions with heavy emulsion nuclei, 12 cases are found, each to be associated with either two 'hammer' tracks or one hammer and a heavy fragment ($Z \geqslant 3$). Our analysis indicates independent production rather than associated production of such fragments.

INTRODUCTION

For the last few years it has been a subject of interest for the workers to see the emission of two or more fragments in an energetic disintegration of heavy emulsion nuclei. For instance, Lovera (1949) and Perkins (1950) looked for the emission of double or triple fragments of $Z \geqslant 3$ in interactions produced by Cosmic Rays using photographic plates; they observed a tendency of associated production of two fragments. Gorichev *et al.* (1961) have analysed the emission frequency of a fragments accompanied by one or more fragments and concluded that the fragments are emitted independently. Gajewski *et al.* (1962) have studied double emission of Li^8-fragments in the disintegrations produced by 9 GeV protons. They have observed the emission of 8 double 'hammer' tracks in 188 cases. They have, however, noticed the indication of independent emission of such fragments, the frequency of emission of which depends on the excitation energy of the disintegrating nucleus. While studying the various properties of 'hammer' tracks and hyperfragments we also looked for double emission of 'hammer' tracks and other heavy fragments ($Z \geqslant 3$).

EXPERIMENTAL PROCEDURE

Ilford G5 emulsions were exposed to a separated negative pion beam of energy 4.6 GeV/C at the Berkeley Bevatron. The emulsion stack was processed and developed at the Bristol Physics Laboratory. Plates were area scanned under low magnification to observe double stars, 'hammer' tracks and stars with one or more heavy fragments. Altogether 51,609 stars have been examined by following black prongs of all the stars up to their end or to the points where they leave the pellicle. Ends of the tracks are closely examined under higher magnification for any secondary track. As soon as a 'hammer' track is seen, the other prongs of the stars are also examined carefully for their charge. A track produced by a particle of charge $Z \geqslant 3$ can ordinarily be distinguished from the rest by studying δ-rays and tappering length. The particles which leave the plate are not followed further. It is because the number of such heavy tracks is small, and they are generally too short to travel very far. No star with more than two heavy fragments is observed in our sample.

Number of stars examined..........................	51,609
Number of 'hammer' tracks........................	405
No. of stars with double 'hammer'................	8
No. of stars with a 'hammer' track and a heavy fragment	4

TABLE I

Details of the events

No.	Parent star size	Range of the tracks in microns		Angles with the primary dir.		Angle between the two fragments
		Hammer 1	Hammer 2	1	2	
1	$15+2\pi^-$	30.74	50.43	83.7°	61.2°	147.9°
2	$15+0\pi^-$	72.57	313.70	83.0°	116.6°	199.6°
3	$11+1\pi^-$	101.30	516.60	102.7°	74.8°	27.9°
4	$12+3\pi^-$	2219.0	246.3	91.5°	77.5°	14.0°
5	$20+5\pi^-$	112.8	19.2	38.1°	68.6°	30.5°
6	$19+4\pi^-$	47.25	110.9	75.8°	19.4°	56.4°
7	$17+4\pi^-$	35.96	103.57	104.7°	82.1°	186.8°
8	$18+2\pi^-$	445.0	19.5	20.0°	54.0°	34.0°
		Hammer	Fragment			
9	$15+3\pi^-$	162.4	33.5	36.2°	15°	51.2°
10	$22+2\pi^-$	124.7	70.1	57.7°	130°	187.7°
11	$15+3\pi^-$	38.7	45.0	128.0°	60°	68°
12	$18+2\pi^-$	38.84	58.1	43°	70°	27°


A
B
2204 μm

Average number of black prongs for different types of stars :–

For,	all stars..	14
	stars with one 'hammer'.........................	13
	star with two 'hammers' or one 'hammer' plus one fragment.........	15

Microphotographs of two stars having double hammer tracks are reproduced in Plate 1.

DISCUSSION .

The number of events obtained so far by us is not sufficient for the investigation of emission frequency, angular distribution etc. of the fragments. As such it is not possible to give a clear cut picture as regards the manner in which the fragments are produced and emitted during such interactions. It is, however, noticed that in eleven out of twelve cases fragments are of unequal ranges. This is most probably due to the fact that the fragments are emitted at different instant during evaporation of the excited nucleus, the longer being emitted at the beginning and the shorter towards the end of the process. It is also seen from our experimental observations given in the above table that there exists no angular relation between the fragments. Hence it appears as if such heavy fragments are emitted independently during the evaporation process.

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